

VESTIBULAR AND SOMATOSENSORY CONVERGENCE IN POSTURAL EQUILIBRIUM CONTROL: INSIGHTS FROM SPACEFLIGHT AND BEDREST STUDIES

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The goal of the Functional Task Test study is to determine the effects of space flight on functional tests that are representative of high priority exploration mission tasks and to identify the key underlying physiological factors that contribute to decrements in performance. We are currently conducting studies on both International Space Station (ISS) astronauts experiencing up to 6 months of microgravity and subjects experiencing 70 days of 6° head-down bed-rest as an analog for space flight. Bed-rest provides the opportunity for us to investigate the role of prolonged axial body unloading in isolation from the other physiological effects produced by exposure to the microgravity environment of space flight. This allows us to parse out the contribution of the body unloading somatosensory component on functional performance. Both ISS crewmembers and bed-rest subjects were tested using a protocol that evaluated functional performance along with tests of postural and locomotor control before and after space flight and bed-rest, respectively. Functional tests included ladder climbing, hatch opening, jump down, manual manipulation of objects and tool use, seat egress and obstacle avoidance, recovery from a fall, and object translation tasks. Astronauts were tested three times before flight, and on 1, 6, and 30 days after landing. Bed-rest subjects were tested three times before bed-rest and immediately after getting up from bed-rest as well as 1, 6, and 12 days after re-ambulation. A comparison of bed-rest and space flight data showed a significant concordance in performance changes across all functional tests. Tasks requiring a greater demand for dynamic control of postural equilibrium (i.e. fall recovery, seat egress/obstacle avoidance during walking, object translation, jump down) showed the greatest decrement in performance. Functional tests with reduced requirements for postural stability showed less reduction in performance. Results indicate that body unloading resulting from prolonged bed-rest impacts functional performance particularly for tests with a greater requirement for postural equilibrium control. These changes in functional performance were paralleled by similar decrement in tests designed to specifically assess postural equilibrium and dynamic gait control. These results indicate that body support unloading experienced during space flight plays a central role in postflight alteration of functional task performance. These data also support the concept that space flight may cause central adaptation of converging body-load somatosensory and vestibular input during gravitational transitions.